REMARKS

Claims 4, 16, 48-51, 53-57, 59 and 60 have been canceled. Claims 1, 5, 7, 11, 12, 14, 15, 17, 25, 44, 52 and 58 have been amended. Claims 61-77 have been added. Claims 1-3, 5-12, 14, 15, 17-22, 24-27, 44, 52, 58 and 61-77 are pending in this application.

The amendment filed on February 21, 2001 has been objected to under 35 U.S.C. § 132 as introducing new matter into the application. According to the Office Action, the added material "a non-uniform flow rate" in claims 1, 7, 17 and 44 is "not supported by the original disclosure." (Office Action at 2). Although Applicant disagrees with this rejection, Applicant has amended and/or cancelled the above-identified claims to correct any perceived deficiencies, and the amended claims are now in condition of allowance.

The amendment filed on February 21, 2001 has been further objected to under 35 U.S.C. § 112, first paragraph, as containing subject matter which does not have support in the specification. According to the Office Action, the added material "a non-uniform velocity" and "the velocity of said portion of said etching fluid rapidly increases at the point of removal from a first value to a second higher value" in claims 1-10, 16, 17-20, 25-27, 44, and 48-60 does not contain "a written description of the invention in full, clear concise manner." (Office Action at 3). Although Applicant disagrees with this rejection, Applicant has amended and/or cancelled the above-identified claims to correct any perceived deficiencies, and the amended claims are now in condition of allowance.

Claims 1-3, 5-9, 14, 17-20, 24, 26 and 44 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Nishizawa et al. (U.S. Patent No. 5,275,184) ("Nishizawa"). The rejection is traversed.

The claimed invention relates to a method for reducing surface contaminants from the air/liquid interface in a wet etching bath. As such, amended independent claim 1 recites "a method for removing surface contaminants from an air/liquid interface" by "rapidly removing an upper portion of the semiconductor processing fluid" present in a processing bath "to remove said surface contaminants from said air/liquid interface." Similarly, amended independent claim 7 also recites a method for "reducing the contamination on a semiconductor wafer" by "rapidly removing an upper portion of said etching fluid from said wet etching bath to remove surface contaminants from an air/liquid interface of said wet etching bath." Amended independent claim 17 also recites a method for etching a semiconductor wafer with an etching fluid, a portion of which being "rapidly removed . . . from the upper surface of said wet etching vessel." Further, dependent claim 8 states that, during the process, "a substantial portion of said etching fluid is removed." This rapid removal causes "the surface tension and eddy current forces holding the contaminants at the air/liquid interface are cleaved and the contaminants flow into the outer weir where they may be collected." (Application at 10, lines 21-25).

Nishizawa does not disclose any of the limitations of the claimed invention. Nishizawa discloses an "apparatus for treating a wafer surface" (Col. 3, line 30) and "a system capable of rapidly substituting treatment solutions" (Col. 3, lines 19-20), but not a method for "rapidly removing an upper portion" of the etching fluid containing "surface contaminants," as independent claims 1 and 7 recite. Nishizawa is also silent about a method for etching a semiconductor wafer by "rapidly removing a portion of said etching fluid from the upper surface of said wet etching vessel," as amended independent claim 17 recites. In Nishizawa, the "old treatment solution inside the container is rapidly displaced by the new treatment solution" (col. 3, lines 54-55) so that the wafers do not "experience contact with air during replacement of the treatment solutions." (Abstract).

Applicant expressly notes that Nishizawa does not address "surface contaminants" or "contaminants from an air/liquid interface." As known in the semiconductor art, surface contaminants at the air/liquid interface of a solution are either

hydrophobic contaminants, which do not suspend in the solution, or contaminants so light that they float on top of the bath and are trapped in surface tension. Surface contaminants are not contaminants suspended in a solution but rather contaminants trapped at the surface of that solution. Eddy currents, also called surface currents, and liquid /air surface tension forces trap the surface contaminants at the surface of the bath, making difficult for the removal of such surface contaminants. (Application at 3, lines 7-10). This is why a sudden, physical force is necessary for the removal of the surface contaminants. Simply overflowing a solution, as in Nishizawa, will not suffice for the break of the eddy currents and/or tension forces and the subsequent removal of surface contaminants.

Applicant further points out that Nishizawa addresses hydrophilic contaminants or contaminants suspended in a cleaning bath, and not "surface contaminants from an air/liquid interface" in such cleaning bath, as in the claimed invention. In addition, Nishizawa displaces the cleaning solution with a rinsing solution, for example water. Thus, Nishizawa is silent about any "surface contaminants at an air/liquid interface," or about the removal of such surface contaminants which do not suspend in a solution, much less about "rapidly removing" the upper portion of an upper portion of such solution, as independent claims 1, 7, 17 and 44 recite. In sum, the present invention is not anticipated by Nishizawa.

Claims 10 and 27 stand rejected under 35 U.S.C. § 103 (a) as being unpatentable over Nishizawa et al. (U.S. Patent No. 5,275,184) in view of Itoh et al. (U.S. Patent No. 5,795,401). The rejection is traversed.

The claimed invention would not have been obvious over Nishizawa in view of Itoh. First, Nishizawa is silent about the rapid removal of "surface contaminants" or of "surface contaminants from an air/liquid interface" by opening a valve, hingedly releasing a door, sliding a door, or telescopically collapsing sidewalls of a vessel containing an etching bath. Second, even if Itoh recites using a paddle, Itoh does not refer to the removal of any contaminants from the etching bath, much less to the removal of "surface contaminants from an air/liquid interface." Itoh merely refers to the scrubbing of a wafer surface using a

rotary brush while pressure is applied by jetting a fluid on the other surface of the wafer. Third, Itoh does not teach or disclose rapidly removing of a substantial portion of the etching liquid. Itoh does not even mention an etching fluid. Itoh refers only to a wash liquid that is purified water and that comes into contact with a rotary brush that cleans the wafer surface. Thus, there is no teaching or suggestion in either of these two references for the claimed subject matter.

The references are also not combinable in view of the diverse areas involved in each reference. Nishizawa refers to wafer surface treatment by using at least two different solutions. Itoh, on the other hand, refers to the actual physical cleaning and scrubbing of the wafer surface by mechanical means such as a cylindrical rotary brush. It is clear, therefore, that the rejection is based on picking and choosing selected portions of each reference, without regard to the totality of teachings of the references, in an attempt to improperly use hindsight to reconstruct the invention. Accordingly, a person of ordinary skills in the art could not have been motivated to combine Nishizawa with Itoh, and withdrawal of this rejection is respectfully requested.

Claims 11 and 21 stand rejected under 35 U.S.C. § 103 (a) as being unpatentable over Nishizawa et al. (U.S. Patent No. 5,275,184) in view of Mohindra et al. (U.S. Patent No. 5,958,146). The rejection is respectfully traversed.

Mohindra et al. ("Mohindra") discloses a cleaning technique for a semiconductor wafer that uses a hot or heated liquid in conjunction with a carrier gas which includes a cleaning enhancement substance. Mohindra discloses the use of control valves in the method of cleaning the semiconductor wafers, and the Office Action points out that "it would have been obvious to one ordinary skill in the art . . . to have provided Nishizawa et al. reference with a valve as taught by Mohindra et al. because the use of valve would have provided another method of removing contaminants from the top of the wafer etching bath." (Office Action at 9). However, the control valves in Mohindra are not used for the rapid removal of "surface contaminants from an air/liquid interface" of an upper portion of the etching fluid, as in the claimed invention. Rather, the control valves

in Mohindra are used to allow a fluid to enter a filter bank, after the fluid was heated in a heater, and then into a wet processor. (Col. 5, lines 47-48; Col. 6, lines 29-35). Undoubtedly, the control valve in this reference merely "meters the carrier gas to the wet processor," and not a processing fluid of an etching bath, as the claimed invention discloses. Further, the control valve in Mohindra is not used to remove any portion of an etching fluid, and surely does not rapidly remove any surface contaminants, as it merely allows passage of a fluid from a filter bank into a processor. Accordingly, there is nothing in the combination of Nishizawa and Mohindra, without the improper use of hindsight reconstruction, to motivate a person of ordinary skills in the art to arrive at the claimed method.

Claims 12, 15, 22 and 25 stand rejected under 35 U.S.C. § 103 (a) as being unpatentable over Nishizawa et al. (U.S. Patent No. 5,275,184) in view of Hayami et al. (U.S. Patent No. 5,474,616) ("Hayami"). The rejection is respectfully traversed.

Hayami teaches a method for rinsing plate-shaped articles, such as semiconductor wafers, as well as cleaning equipment for the rinsing method. (Col. 2, lines 40-43). For this, Hayami uses a cleaning bath in which streams are directed upward from orifices of a feed pipe located near the bottom of the cleaning bath. (Col. 6, lines 1-4; Figures 41-42). The diameters of the orifices are adjusted "so that the jetting pressure of the cleaning water at all the orifices are uniform." (Col. 6, lines 11-14). Most importantly, Hayami specifically notes that "it is necessary to stably maintain a state where a part of the surface of the cleaning water bulges so as to form uniform streams on the surface of the cleaning water." (Col. 7, lines 13-16). Thus, while these uniform streams which are directed toward the rear and front walls are formed on the surface of the cleaning water, the semiconductor wafers are "gradually brought into the cleaning water." (Col. 14, lines 40-45).

The claimed invention would not have been obvious over Nishizawa in view of Hayami. First, both Nishizawa and Hayami are silent about the rapid removal of "surface contaminants" or of "contaminants from an air/liquid interface" by "hingedly releasing a

door" or by "telescopically collapsing sidewalls of a vessel," as amended independent claims 12, 15 and 25 recite, and independent claim 22 recites. Second, Hayami does not teach or disclose the rapid removal of surface contaminants from a semiconductor processing fluid, as amended independent claims 12, 15 and 25 recite. Hayami does not even teach or disclose a method for "etching a semiconductor wafer," as independent claims 22 and 25 recite. Hayami refers only to water as the rinsing/cleaning liquid and the water in Hayami is not rapidly removed.

The references are also not combinable in view of the diverse areas involved in each reference. Nishizawa refers to wafer surface treatment by using at least two different solutions. Hayami, on the other hand, refers to the rinsing and cleaning of the wafers after the step of etching such wafers. It is clear, therefore, that the rejection is based on picking and choosing selected portions of each reference, in an attempt to improperly use hindsight to reconstruct the invention. Accordingly, a person of ordinary skill in the art would not have been motivated to combine Nishizawa with Hayami and withdrawal of this rejection is respectfully requested.

New claims 61-77 have been added to round out the scope of protection afforded by the invention. The cited references fail to teach or suggest the subject matter of these claims, including a "method for removing surface contaminants from an air/liquid interface of a semiconductor processing bath" by "rapidly removing an upper portion of a semiconductor processing fluid present in said bath . . . to break eddy currents holding said surface contaminants at said air/liquid interface" (claim 61) or "to break surface tension forces holding said surface contaminants at said air/liquid interface" (claim 68). The cited references also fail to teach or suggest a "method for reducing the contamination on a semiconductor wafer" by "breaking eddy currents of said wet etching bath by rapidly removing an upper portion of said etching fluid from said wet etching bath, said act of breaking said eddy currents further releasing surface contaminants which are formed at an air/liquid interface of said wet etching bath and held at said air/liquid interface by said

eddy currents," as newly added claim 75 recites, or by "breaking surface tension forces of said wet etching bath by rapidly removing an upper portion of said etching fluid from said wet etching bath, said act of breaking said surface tension forces further releasing surface contaminants which are formed at an air/liquid interface of said wet etching bath and held at said air/liquid interface by said eddy currents," as newly added claim 76 recites.

The cited references also fail to teach or suggest a "method for reducing the contamination on a semiconductor wafer" by "processing said semiconductor wafer in a static etching bath containing an etching fluid; and rapidly removing an upper portion of said etching fluid while said semiconductor wafer is in said static etching bath," as newly added claim 77 recites.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

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Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

1. (thrice amended) A method for removing surface contaminants from an air/liquid interface of a semiconductor processing bath for processing semiconductor wafers, said method comprising:

rapidly removing [at a non-uniform flow rate] an upper portion of a semiconductor processing fluid present in said bath while said wafers are in said bath to remove said surface contaminants from said air/liquid interface.

5. (amended) The method of removing contaminants from a processing bath for processing semiconductor wafers according to claim [4] 1, wherein said [wherein said] semiconductor processing bath is an etching bath.

7. (thrice amended) A method for reducing the contamination on a semiconductor wafer from a wet etching bath comprising:

processing said semiconductor wafer in said wet etching bath containing an etching fluid;

subsequently rapidly removing [at a non-uniform flow rate] an upper portion of said etching fluid from said wet etching bath to remove surface contaminants from [the surface] an air/liquid interface of said wet etching bath while retaining said semiconductor wafer in said wet etching bath; and

subsequently removing said semiconductor wafer from said wet etching bath.

11. (thrice amended) A method for removing surface contaminants from an air/liquid interface of a semiconductor processing bath for processing semiconductor wafers, said method comprising rapidly removing an upper portion of a semiconductor

processing fluid present in said bath, while said wafers are in said bath, by opening a valve in said bath to remove said surface contaminants from said air/liquid interface.

12. (thrice amended) A method for removing surface contaminants from an air/liquid interface of a semiconductor processing bath for processing semiconductor wafers, said method comprising rapidly removing an upper portion of a semiconductor processing fluid present in said bath, while said wafers are in said bath, by hingedly releasing a door located at an upper portion of said bath to remove said surface contaminants from said air/liquid interface.

14. (thrice amended) A method for removing surface contaminants from an air/liquid interface of a semiconductor processing bath for processing semiconductor wafers, said method comprising rapidly removing an upper portion of a semiconductor processing fluid present in said bath, while said wafers are in said bath, by rapidly removing a wafer boat containing said semiconductor wafer from said bath to remove said surface contaminants from said air/liquid interface.

15. (thrice amended) A method for removing surface contaminants from an air/liquid interface of a semiconductor processing bath for processing semiconductor wafers, said method comprising rapidly removing an upper portion of a semiconductor processing fluid present in said bath, while said wafers are in said bath, by telescopically collapsing sidewalls of a vessel containing said bath to remove said surface contaminants from said air/liquid interface.

17. (thrice amended) A method for etching a semiconductor wafer, said method comprising:

placing an etching fluid into a wet etching vessel;

placing said semiconductor wafer in said etching fluid;

contacting said semiconductor wafer with said etching fluid for a predetermined time;

rapidly removing a portion of said etching fluid from the upper surface of said wet etching vessel [at a non-uniform flow rate] while keeping said semiconductor wafer immersed in said etching fluid; and

removing said semiconductor wafer from said etching fluid.

25. (thrice amended) A method for etching a semiconductor wafer, said method comprising:

placing an etching fluid into a wet etching vessel;

placing said semiconductor wafer in said etching fluid;

contacting said semiconductor wafer with said etching fluid for a predetermined time; and

rapidly removing a portion of said etching fluid from the upper surface of said wet etching vessel [at a non-constant velocity] by telescopically collapsing sidewalls of said wet etching vessel.

44. (thrice amended) A method for reducing the contaminants on a silicon wafer during a wet etching process, said method comprising:

immersing a wafer boat in an etching vessel having an etching fluid therein for a sufficient time to etch said silicon wafer; and

rapidly removing said wafer boat from said etching vessel to remove surface contaminants residing on the upper surface of said etching fluid by causing said etching fluid to spill out of said vessel [at a non-uniform flow rate].

52. (amended) A method for removing surface contaminants from a semiconductor processing bath for processing semiconductor wafers, said method comprising removing an upper portion of a semiconductor processing fluid present in said bath, while said wafers are in said bath, by sliding a door located at an upper portion of said bath [in a manner such that the velocity of said upper portion of said semiconductor processing fluid rapidly increases at the point of removal from a first value to a second higher value].

58. (amended) A method for etching a semiconductor wafer, said method comprising:

placing an etching fluid into a wet etching vessel;

placing said semiconductor wafer in said etching fluid;

contacting said semiconductor wafer with said etching fluid for a predetermined time; and

removing a portion of said etching fluid from the upper surface of said wet etching vessel by sliding a door located at an upper portion of said wet etching vessel [in a manner such that the velocity of said portion of said etching fluid rapidly increases at the point of removal from a first value to a second higher value].